MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2022/2023 (TERM ID 2210)

BMP2014 – MATHEMATICAL PROGRAMMING

(All sections / Groups)

17 FEBRUARY 2023
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **THREE (3)** printed pages excluding cover page.
2. Answer **ALL FOUR (4)** questions.
3. Please write all your answers in the Answer Booklet provided.

QUESTION 1 (25 MARKS)

(a) Determine an optimal table using **simplex method** for the following Linear Programming problem:

$$\text{Maximize } Z = 50x_1 + 20x_2$$
$$\text{Subject to:}$$
$$9x_1 + 3x_2 \leq 50$$
$$5x_1 + 4x_2 \leq 35$$
$$3x_1 \leq 15$$
$$x_1, x_2 \geq 0$$

(13 marks)

(b) Show that the following Linear Programming is infeasible using the Two-Phase Simplex Method:

$$\text{Maximize } Z = 2x_1 + 5x_2$$
$$\text{Subject to:}$$
$$3x_1 + 2x_2 \geq 6$$
$$2x_1 + x_2 \leq 2$$
$$x_1, x_2 \geq 0$$

(12 marks)

QUESTION 2 (25 MARKS)

Consider the standard form LP:

$$\text{Maximize } Z = 5x_1 + 3x_2$$
$$\text{Subject to:}$$
$$2x_1 + 5x_2 + 5x_3 = 25$$
$$x_1 + 2x_2 + 2x_4 = 30$$
$$x_1, x_2, x_3, x_4 \geq 0$$

(a) Determine the direction of most rapid improvement in the objective function at any solution x. **(3 marks)**

(b) Compute the projection matrix **P** for the main equality constraints.
The formulae of $\mathbf{P} = \mathbf{I} - \mathbf{A}^T\left(\mathbf{A}\mathbf{A}^T\right)^{-1}\mathbf{A}$ and leave your answers in fractional form.
(15 marks)

(c) Apply your P to project the direction obtained in part (a).
Use these formulae: $\Delta\mathbf{x} = \mathbf{P}\mathbf{d}$ and leave your answers in fractional form.
(4 marks)

(d) Verify that Δx resulted in part (c) is improving at any interior point solution.
(3 marks)

Continued...

QUESTION 3 (25 MARKS)

(a) Consider the following linear programming model:

$$\text{Maximize } Z = 12x_1 + 18x_2 + 10x_3$$
$$\text{Subject to:}$$
$$2x_1 + 3x_2 + 4x_3 \leq 50$$
$$x_1 + x_2 + x_3 \leq 20$$
$$x_2 + 2x_3 \leq 10$$
$$x_1, x_2, x_3 \geq 0$$

And its optimal table is:

Z	x_1	x_2	x_3	s_1	s_2	s_3	RHS
1	0	0	24	6	0	2.5	325
0	1	0	-1	0.5	0	-0.2	10
0	0	0	0	-0.5	1	0.275	0
0	0	1	2	0	0	0	50

Find the dual for above model and state the duality optimal solution. What is the dual's objective function value?

(10 marks)

(b) Consider the following NLP:

$$\text{Maximize } f(x_1, x_2) = 6x_1x_2 - 5x_1^2 - 2x_2^2$$

Find the approximate solution within $\varepsilon = 0.4$ by applying the gradient search procedure. Use the initial solution of $x_0 = (1,1)$.

(15 marks)

Continued...

QUESTION 4 (25 MARKS)

(a) Biggio's store has four employees available to assign to four departments in the store. The average daily hours for each of the employees for each department is shown in the following table:

Employee	Department (Hours)			
	1	2	3	4
Annie	340	160	610	290
Beth	560	370	520	450
Carla	270	220	350	420
Debbie	360	190	630	150

Determine which employee to assign to each department and indicate the total expected daily hours.

(10 marks)

(b) The management of the Excellent Furniture Corporation decided to expand the production capacity at its factory. It also revised the requirements at its three plants in order to minimize the transportation costs. The transportation costs ($), daily supplies and daily demands are provided as below:

From	To			Supply
	1	2	3	
PA	40	32	48	800
PB	20	20	16	1000
PC	24	36	20	400
Demand	300	900	1000	

Determine a basic feasible solution using Vogel's Approximation Method. Then, solve the transportation problem to obtain the minimum cost.

(15 marks)

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